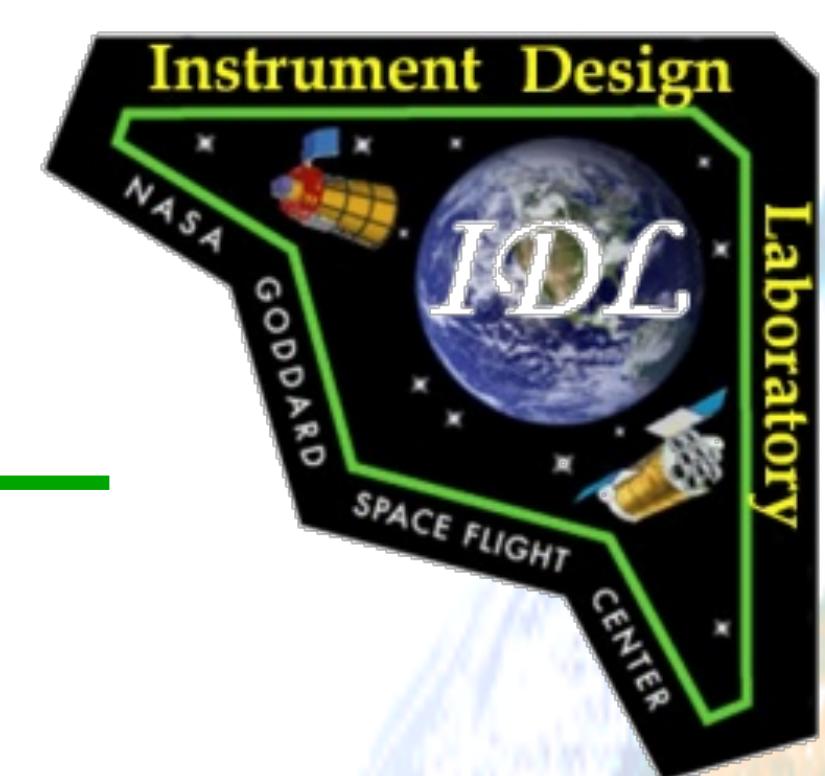


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Ocean Color Experiment Ver. 2 (OCE2)

~ Concept Presentations ~

Thermal

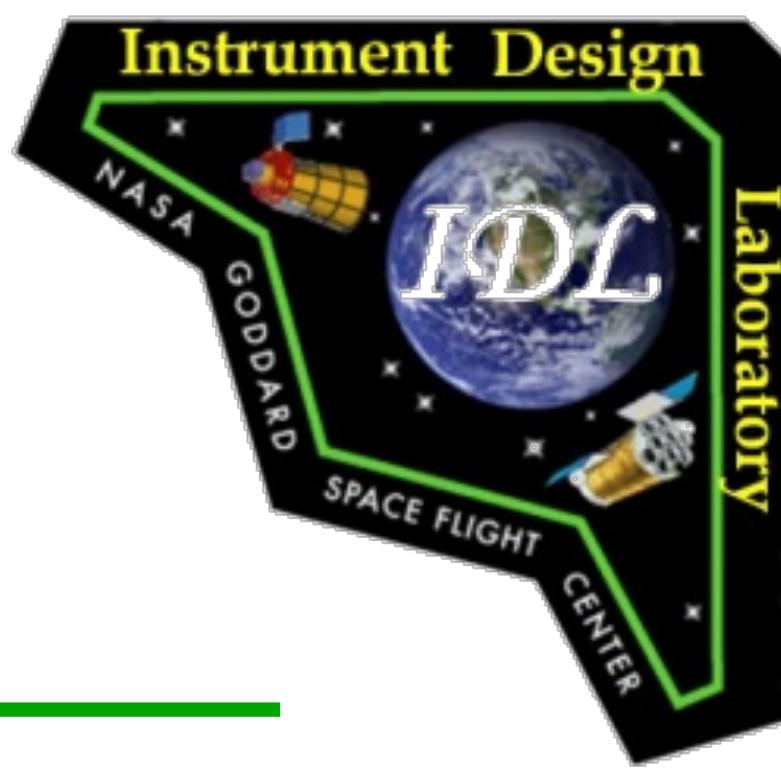
Mike Choi

April 27, 2011

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N A S A G O D D A R D S P A C E F L I G H T C E N T E R



Thermal Requirements

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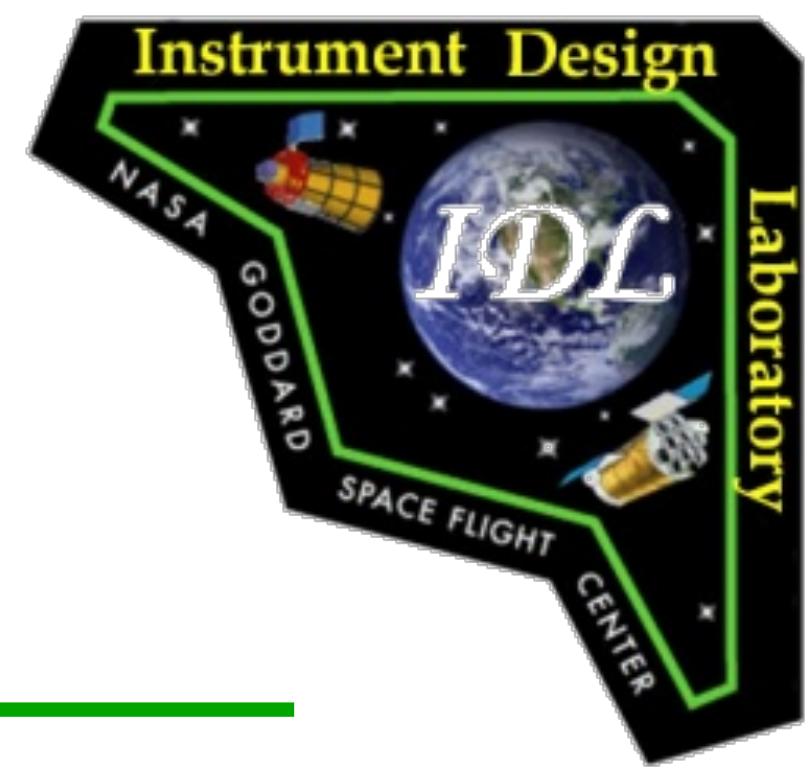
Component	Operating (°C)	Stability, Operating (°C)	Survival (°C)
Silicon PIN Photodiode (138)	20	±1	-40 to 80
Silicon PIN Preamp, FET switches, FET driver (138)	20	±5	-40 to 80
InGaAs PIN Photodiode (6)	-20	±1	-40 to 80
InGaAs PIN Preamp, FET switches, FET driver (6)	-20	±5	-40 to 80
Fiber Optics (144)	25	±5	N/A
Digitizer Electronics Box (2)	-10 to 40	N/A	-20 to 50
Main Electronics Box	-10 to 40	N/A	-20 to 50
Mechanism Control Electronics Box	-10 to 40	N/A	-20 to 50



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Thermal, p2
Presentation Version



Power Dissipation

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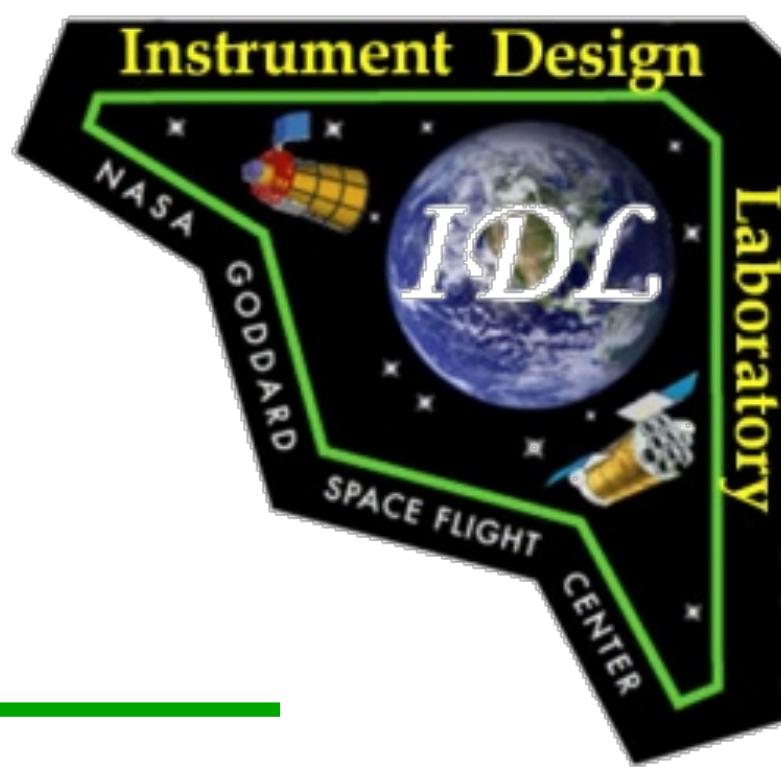
Component	Power Dissipation (W)
Silicon PIN Photodiode (138)	1 nano each
Silicon PIN Preamp, FET switches, FET driver (138)	1 each
InGaAs PIN Photodiode (6)	1 nano each
InGaAs PIN Preamp, FET switches, FET driver (6)	1 each
Fiber Optics (144)	0
Digitizer Electronics Box (2)	41 each
Main Electronics Box	135
Mechanism Control Electronics Box	24



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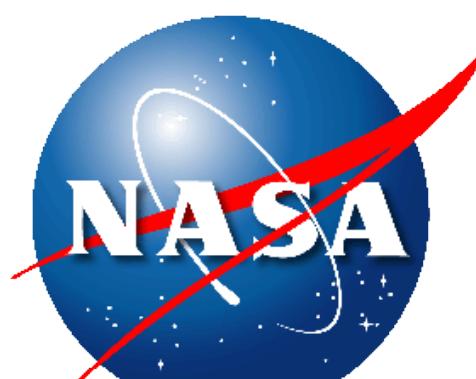
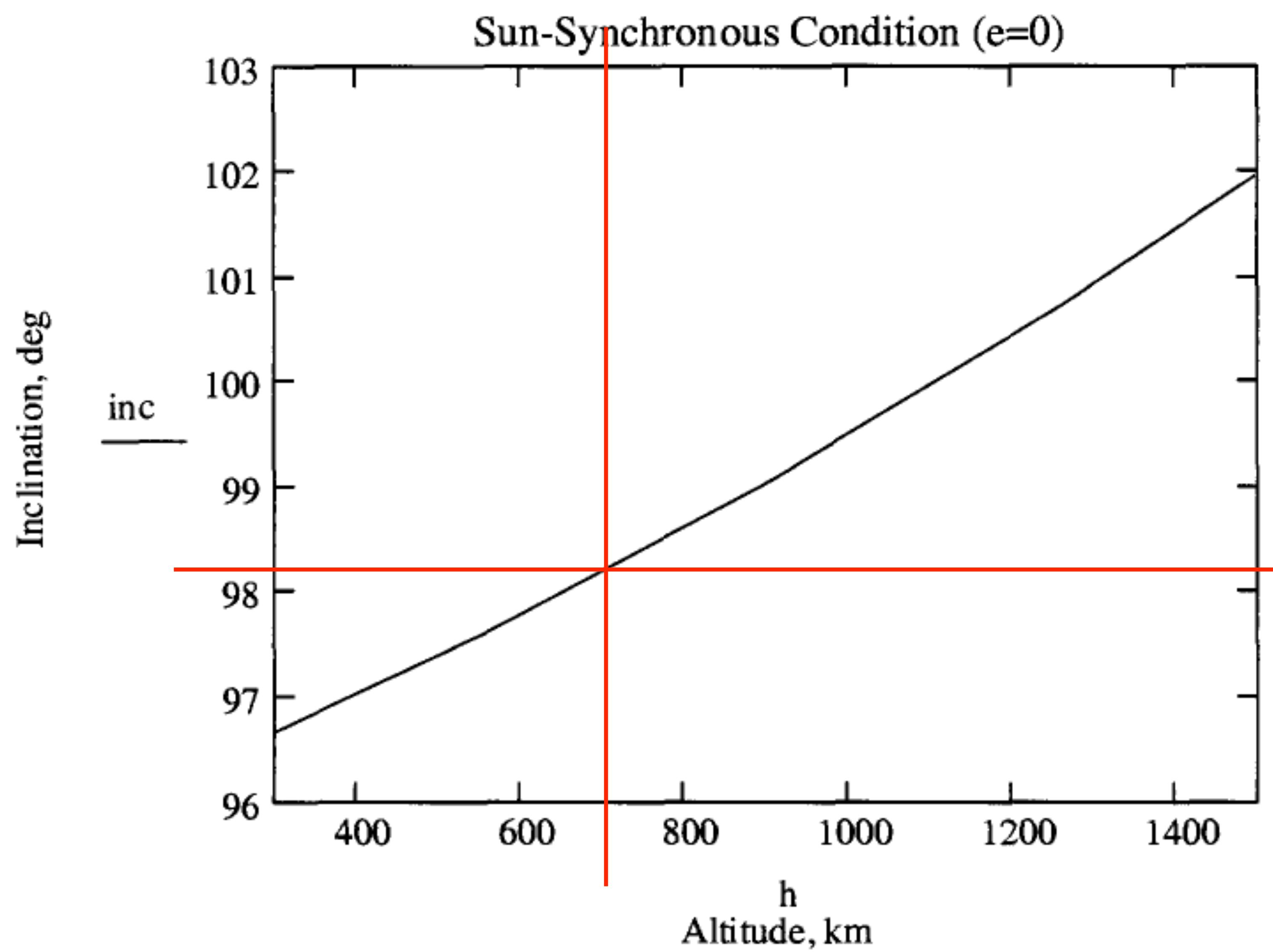
Thermal, p3
Presentation Version



Orbit Parameters

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- Sun synchronous, near-polar, near-circular orbit
 - Crossing equator at 1100-1300 local time
 - 700 km altitude
- 98.16° inclination



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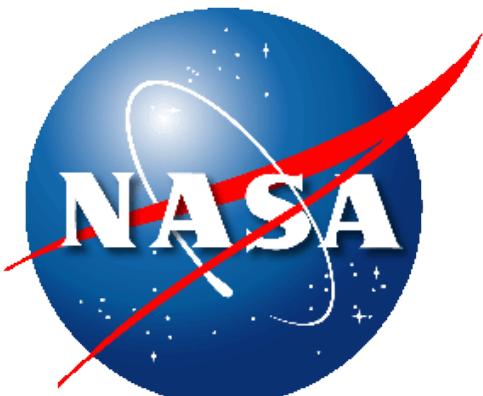
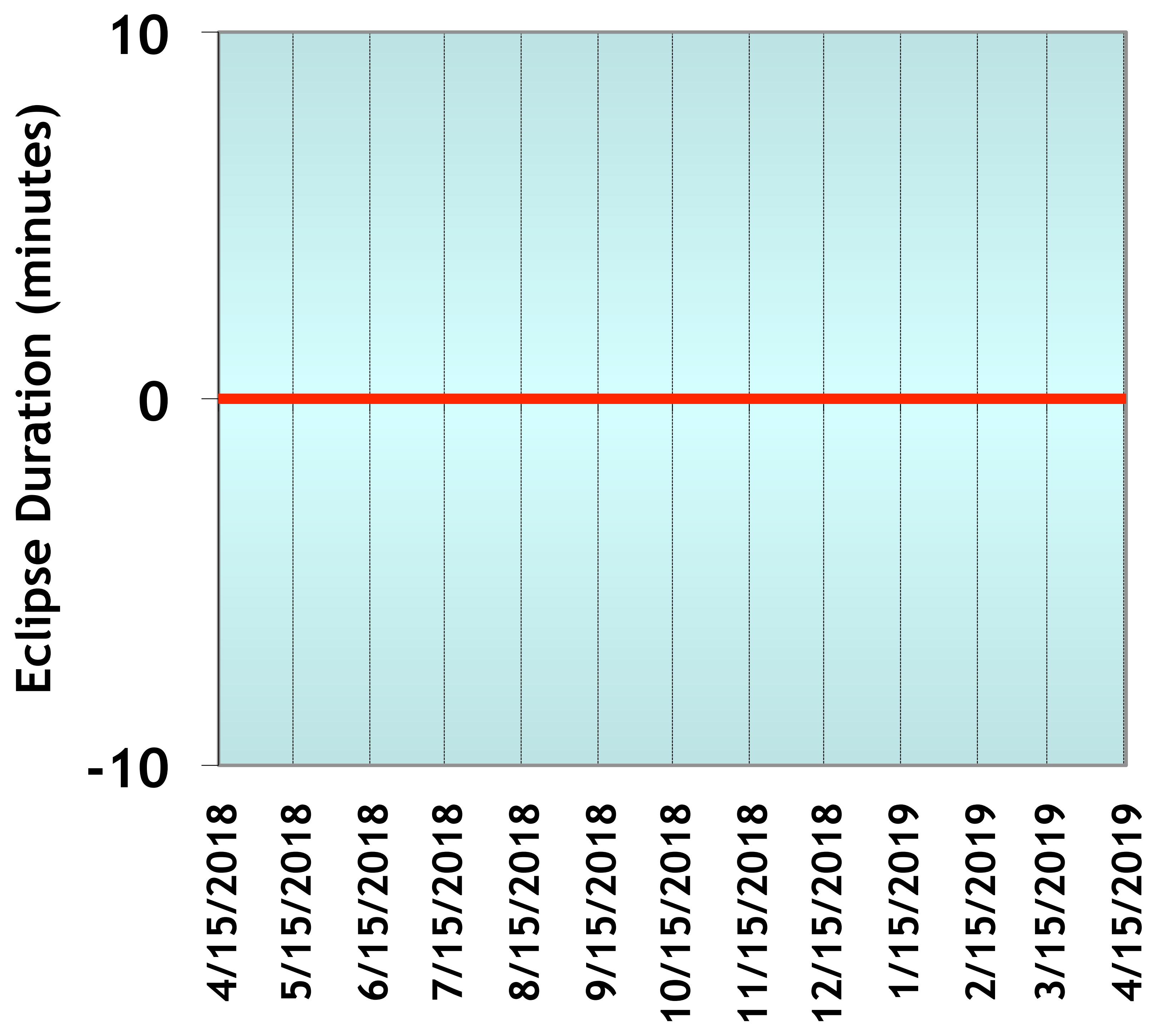
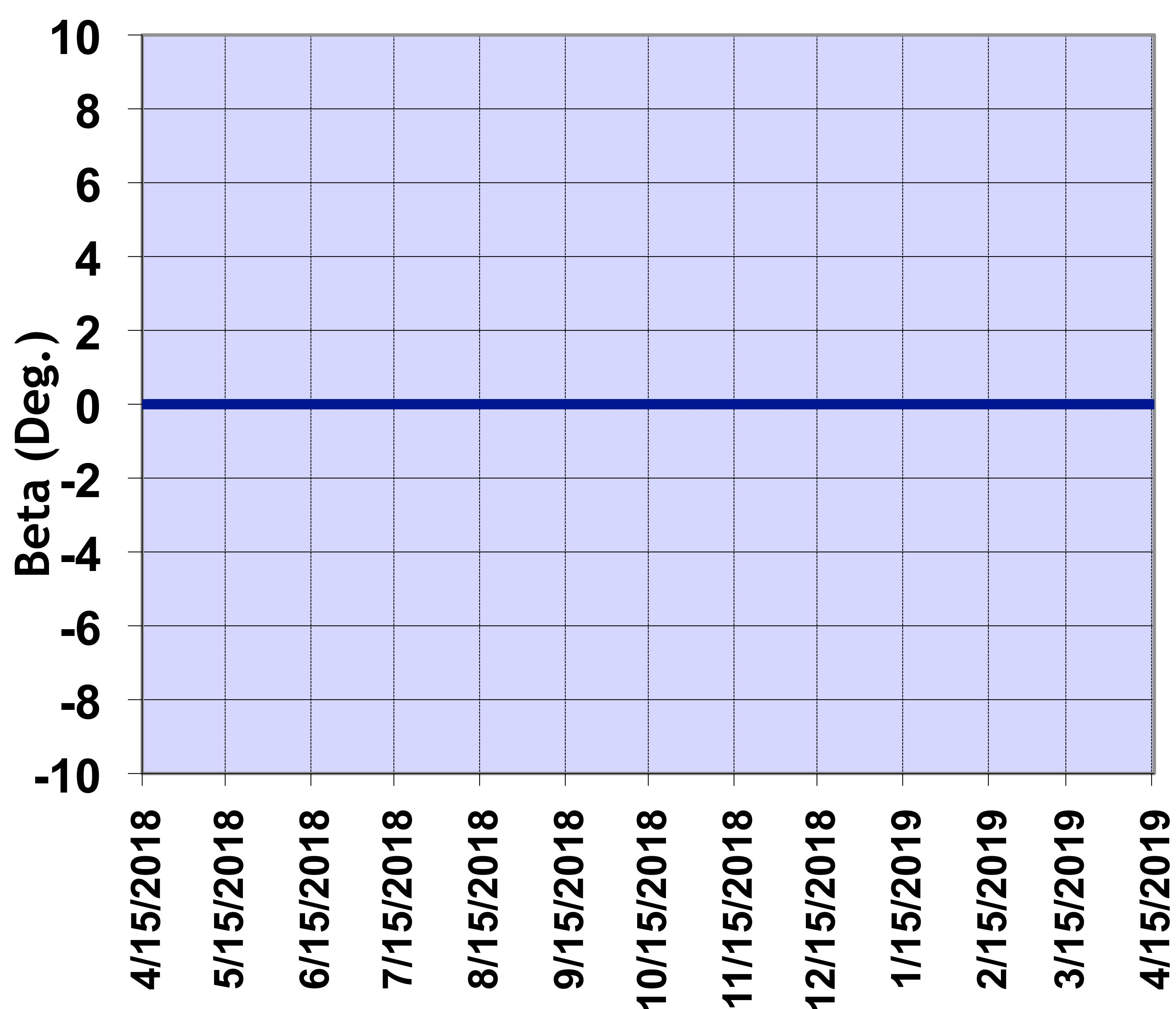
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Thermal, p4
Presentation Version

Beta Angle and Eclipse: 1300 Equatorial Crossing



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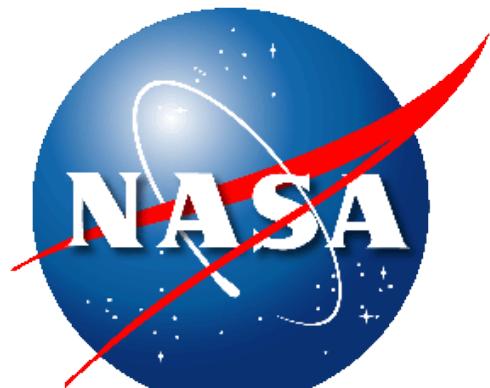
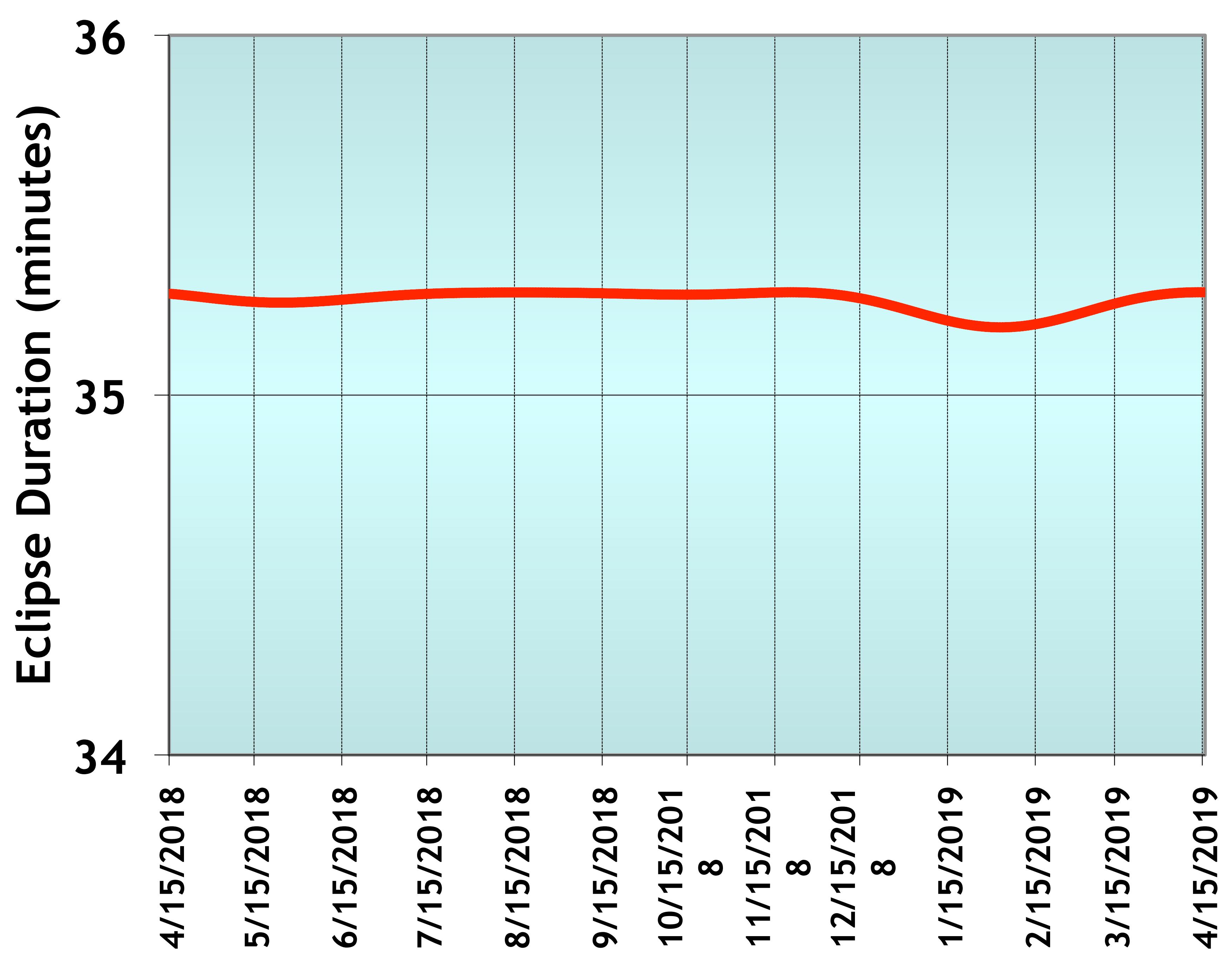
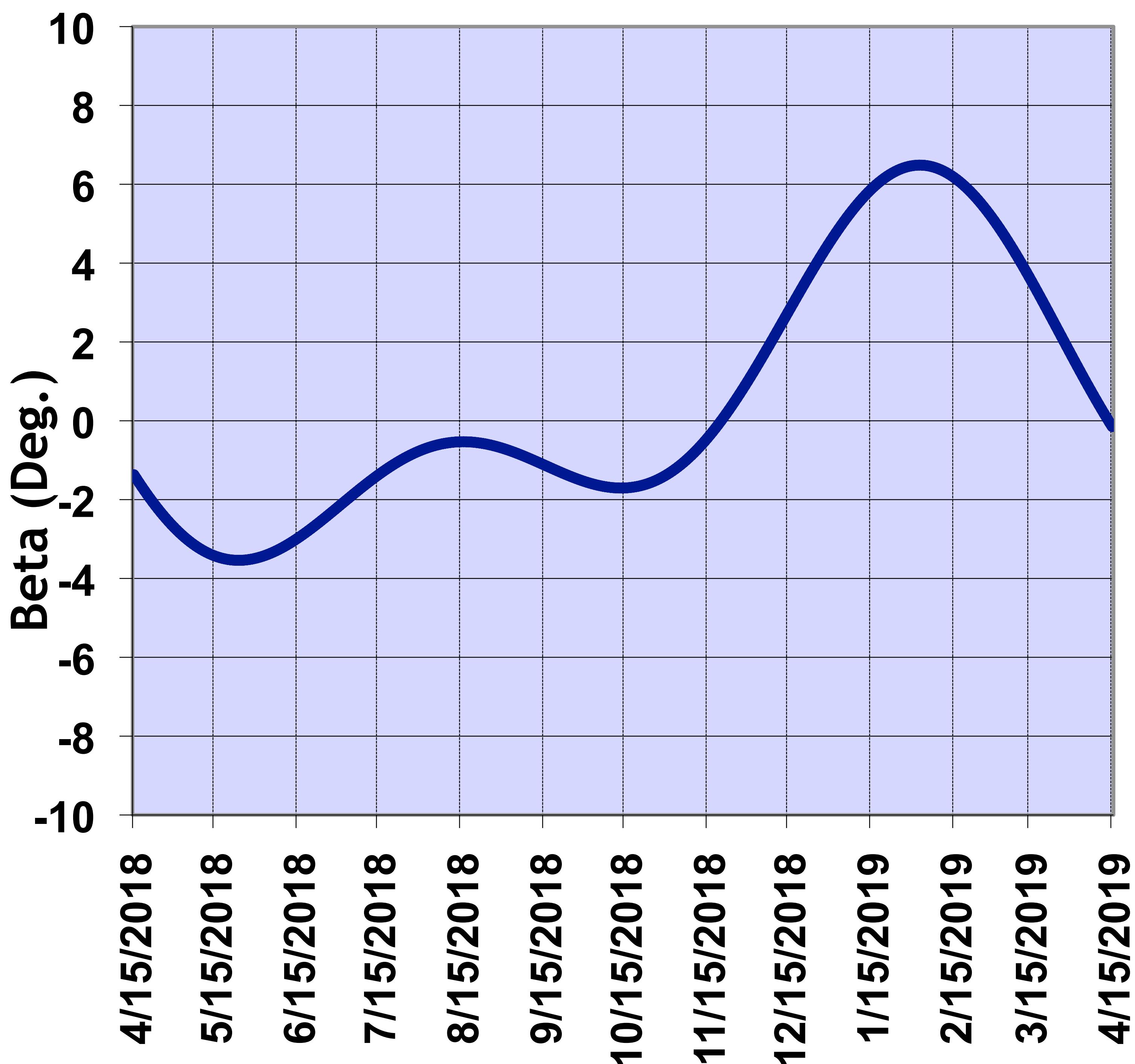
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Thermal, p5
Presentation Version

Beta Angle and Eclipse: 1200 Equatorial Crossing



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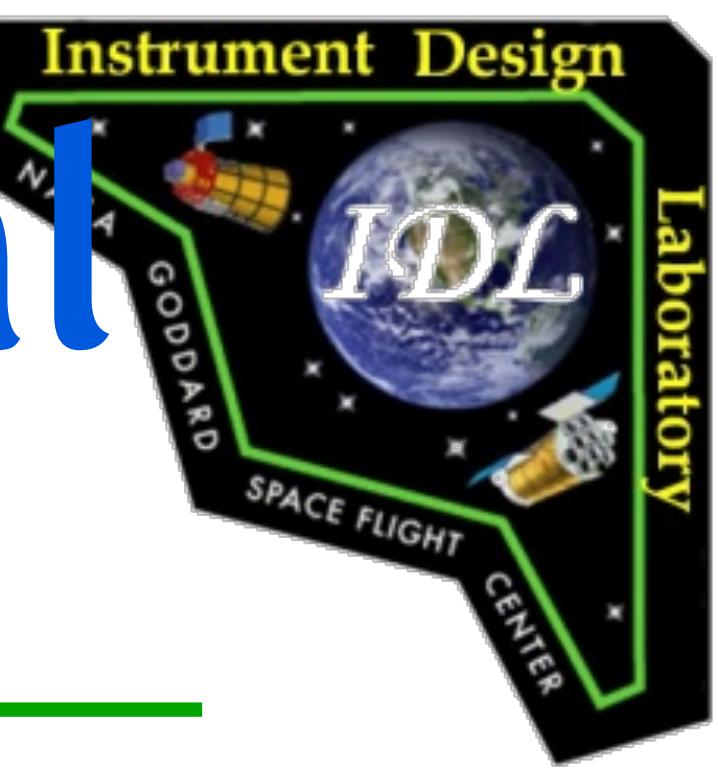


OCE2 Study Week: 4/23 - 4/27/12

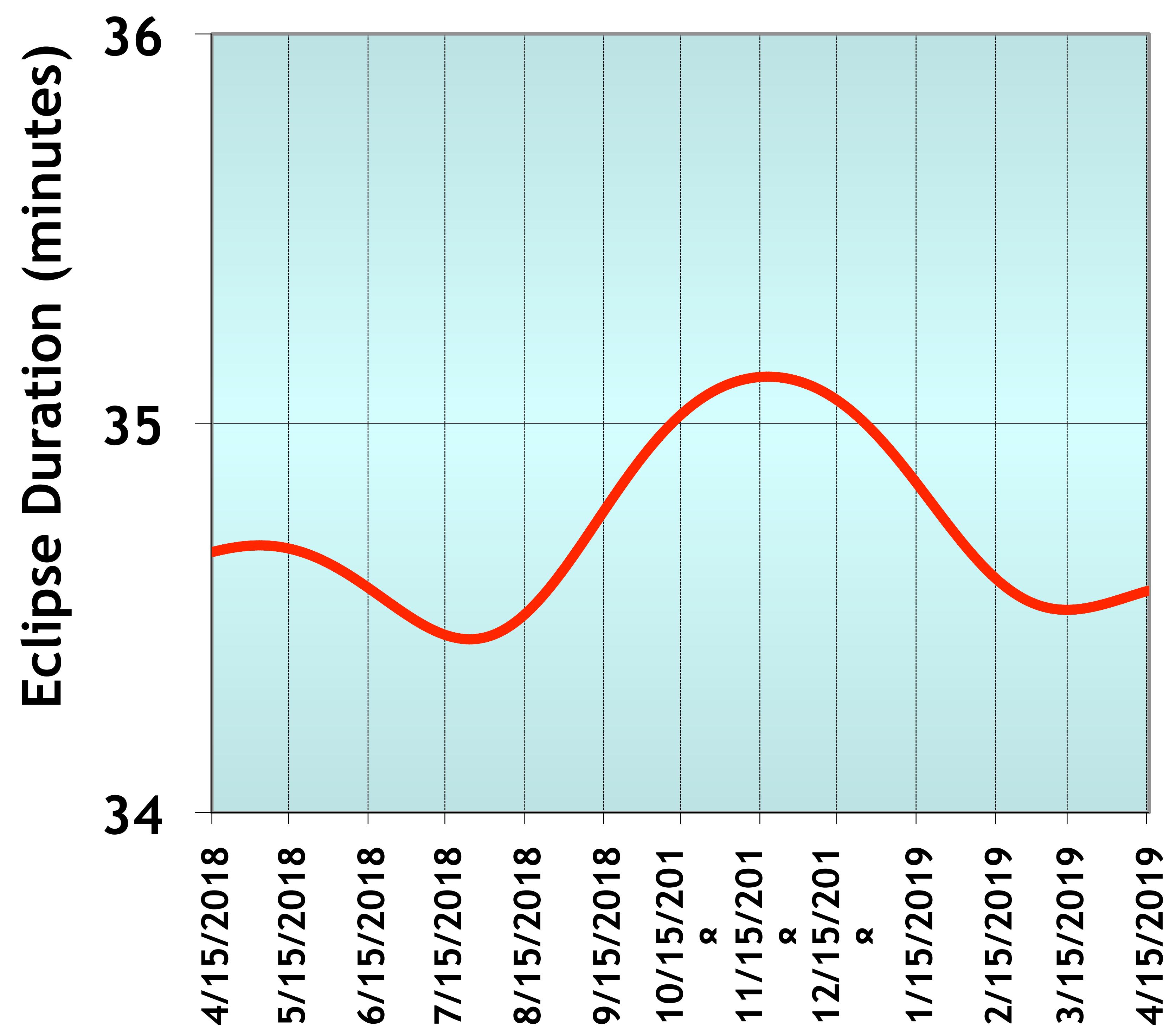
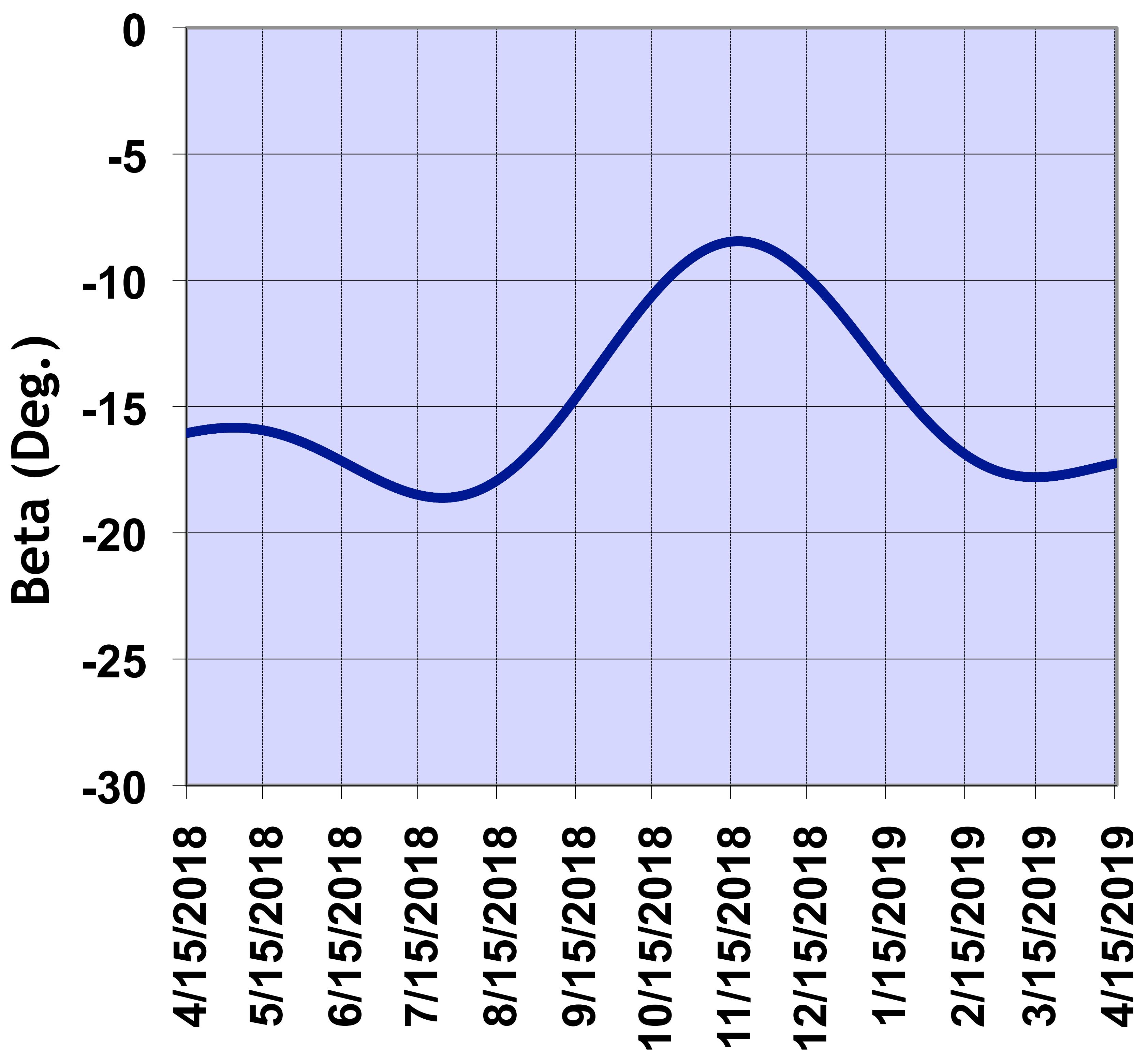
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Thermal, p6
Presentation Version

Beta Angle and Eclipse: 1100 Equatorial Crossing



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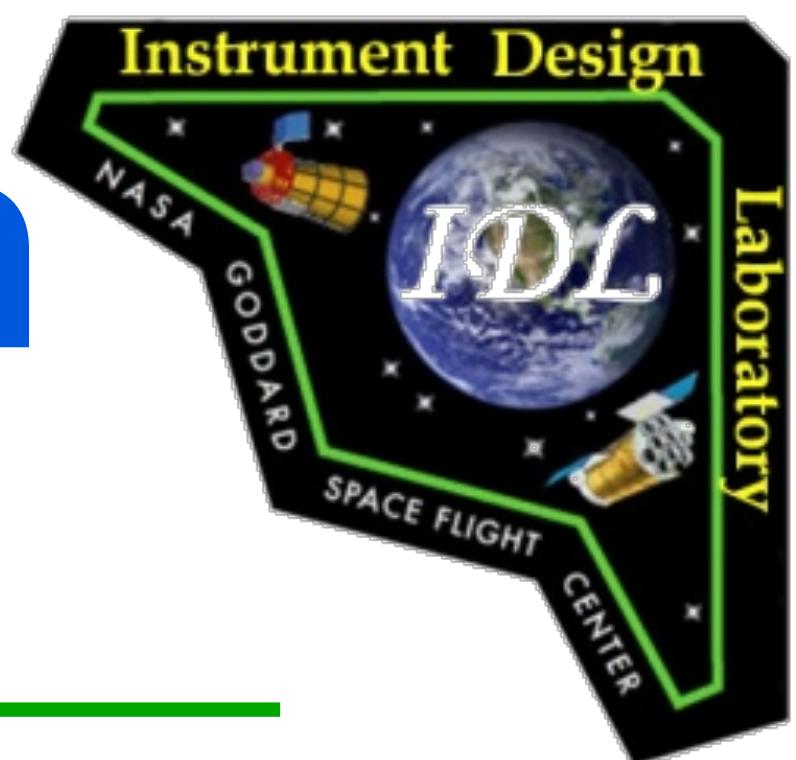


OCE2 Study Week: 4/23 - 4/27/12

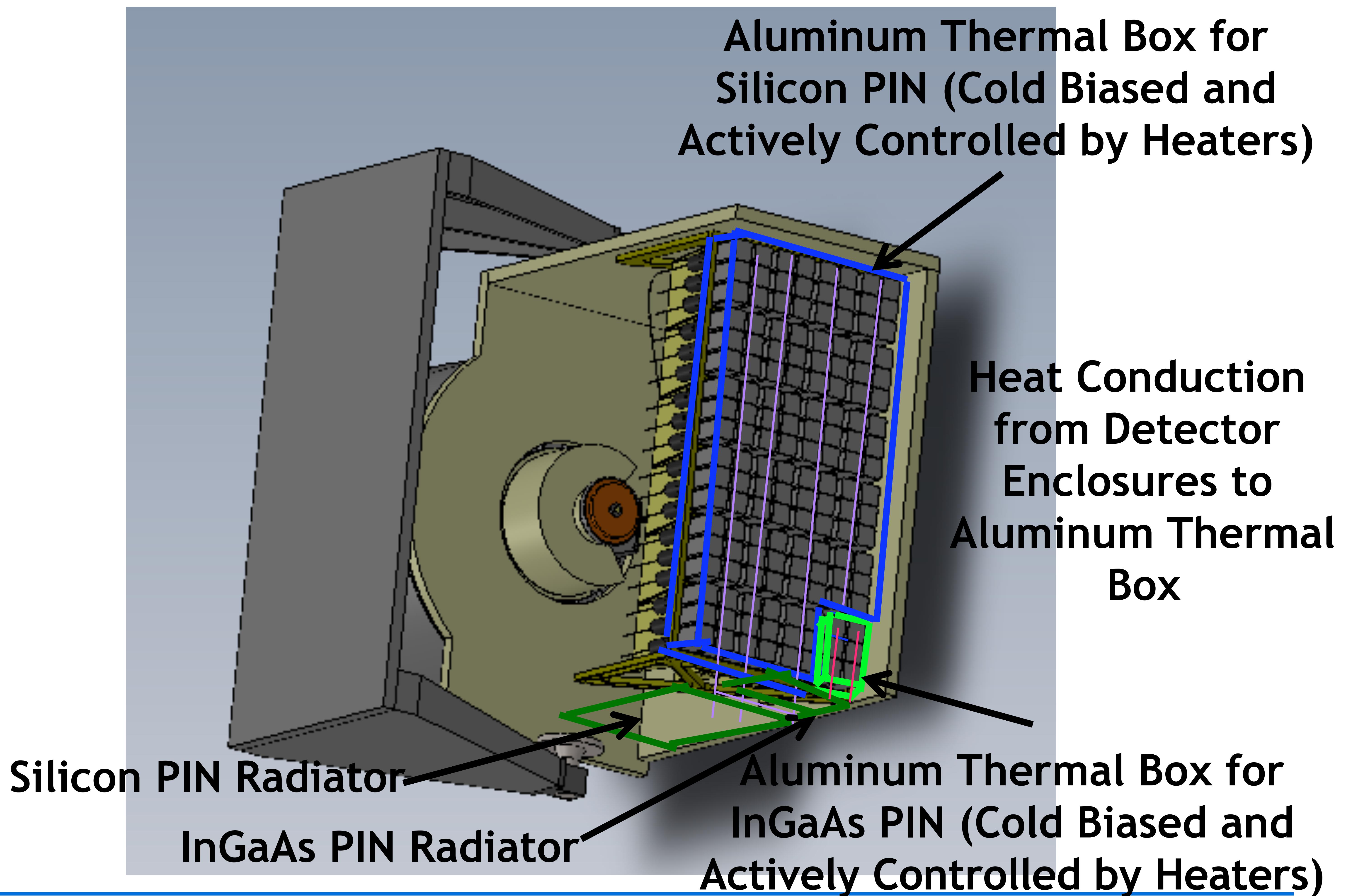
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Thermal, p7
Presentation Version

Detector and Pre-Amp Heat Rejection System



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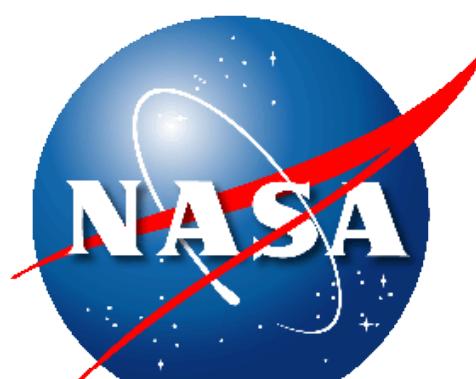
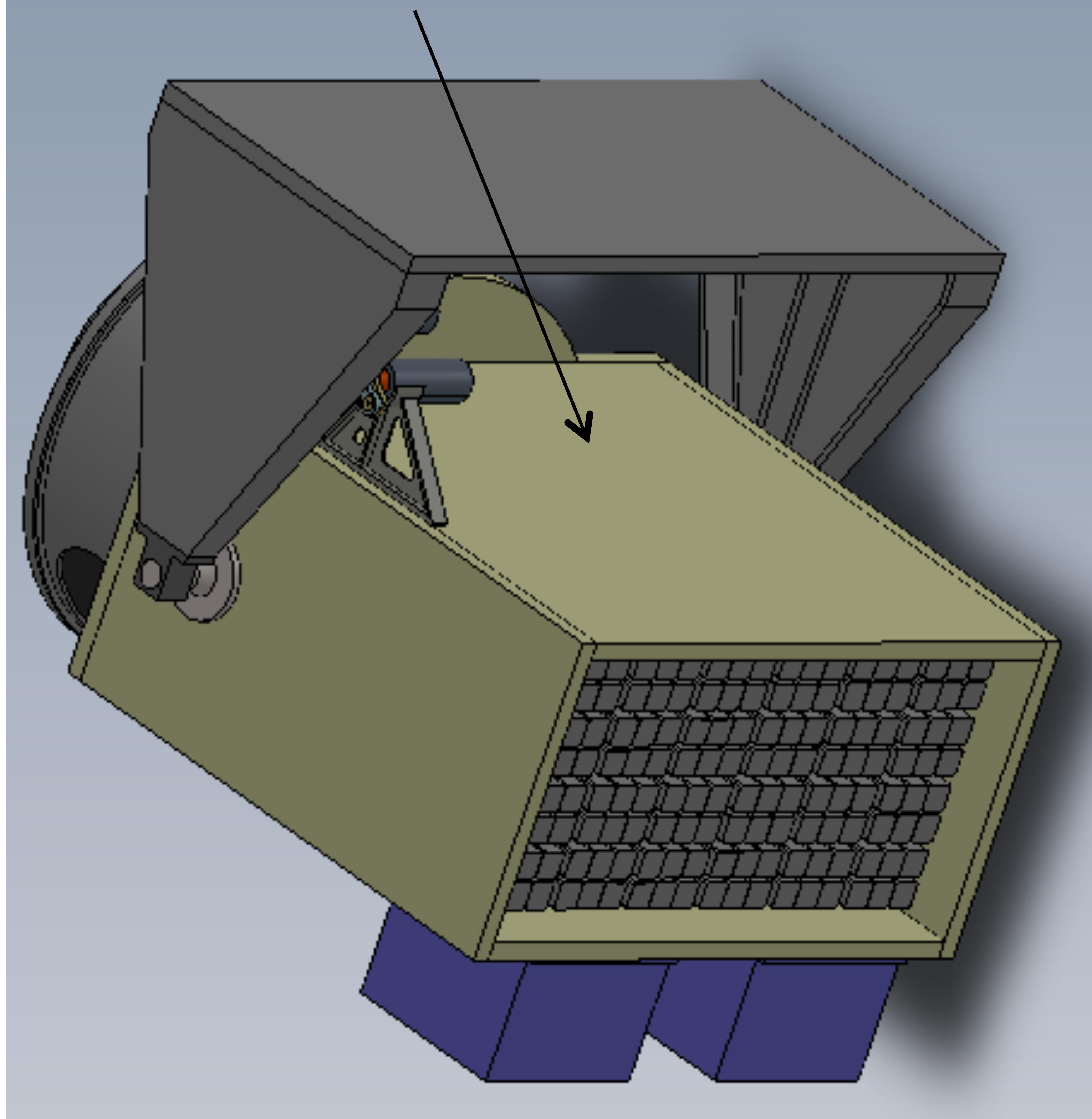
Thermal, p8
Presentation Version



Fiber Optics Thermal Control

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**Heaters & Thermostats for Fiber Optics
Enclosure Which is Covered with MLI**

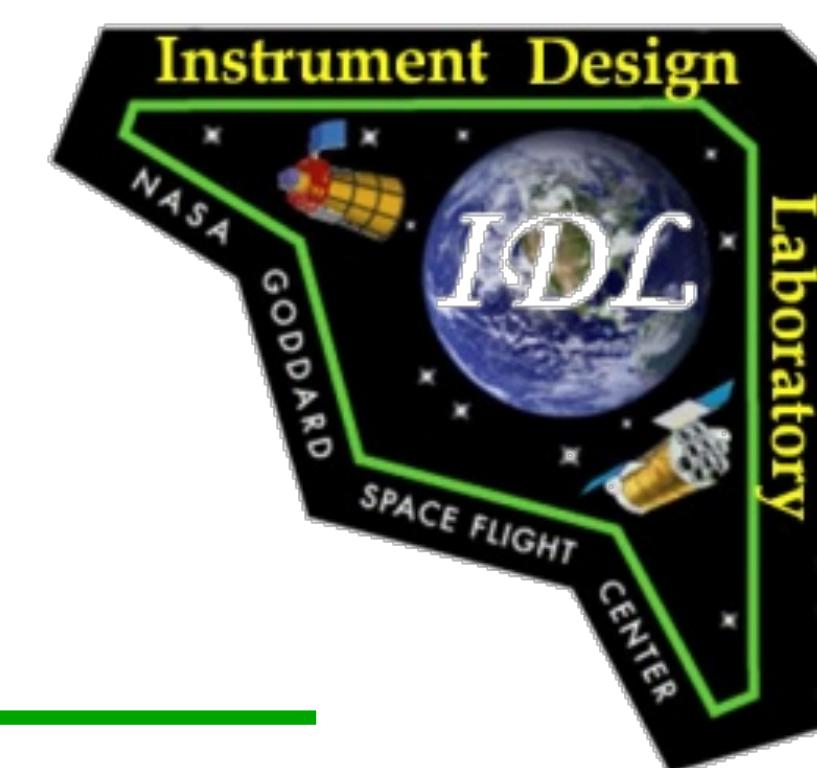


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Thermal, p9
Presentation Version

Operating Mode Heater Circuits with Electronics Heater Controller



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	# of Primary Heater Circuits	# of Redundant Heater Circuits	# of Thermistors in Primary Heater Circuits	# of Thermistors in Redundant Heater Circuits
Silicon PIN & Preamp Thermal Box	6	6	6	6
InGaAs PIN & Preamp Thermal Box*	6	6	6	6
Total	12	12	12	12

*Assuming InGaAs not adjacent to each other

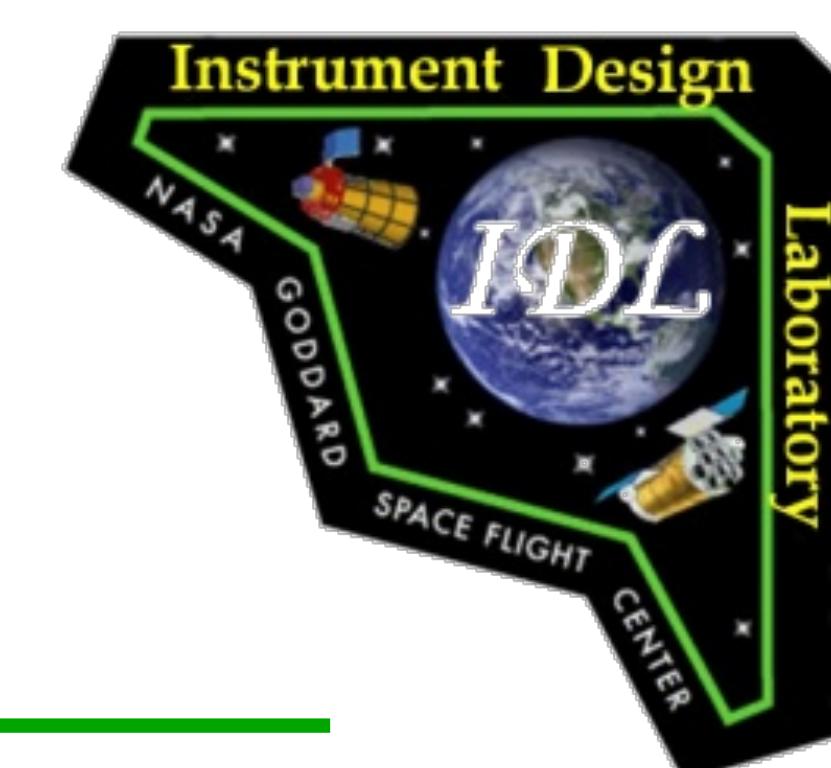


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Thermal, p10
Presentation Version

Operating Mode Heater Circuits with Mechanical Thermostats



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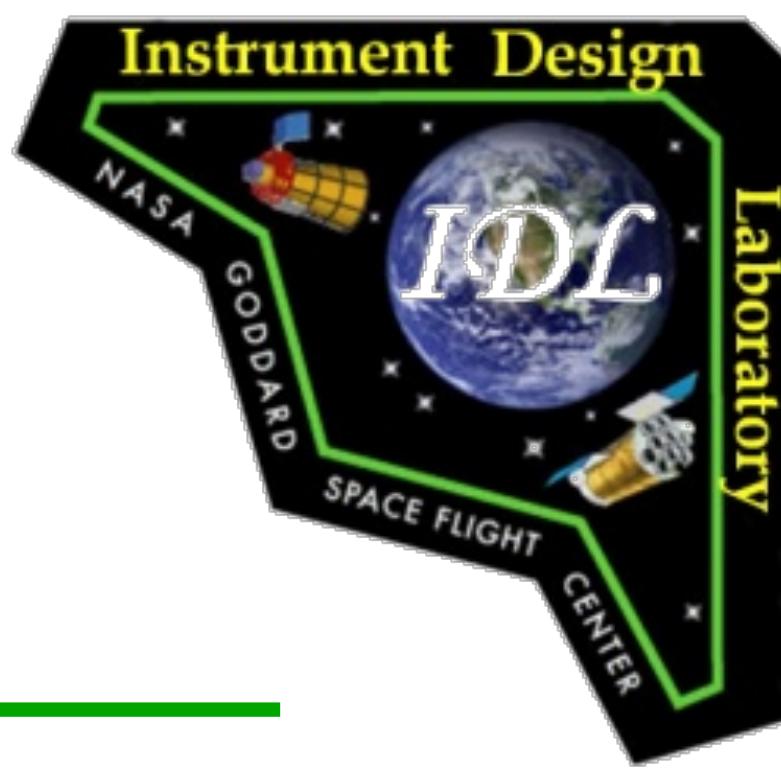
	# of Primary Heater Circuits	# of Redundant Heater Circuits	# of Thermostats in Primary Heater Circuits	# of Thermostats in Redundant Heater Circuits
Fiber Optics Enclosure	6	6	12	12
Optics Housing	4	4	8	8
	10	10	20	20



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Thermal, p11
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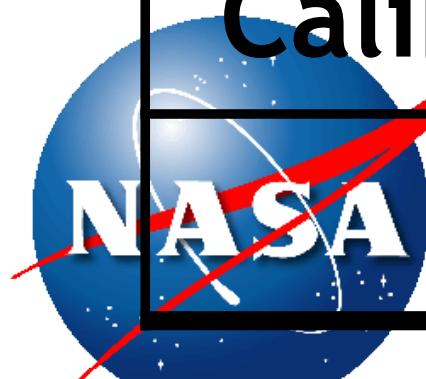


Survival Heaters

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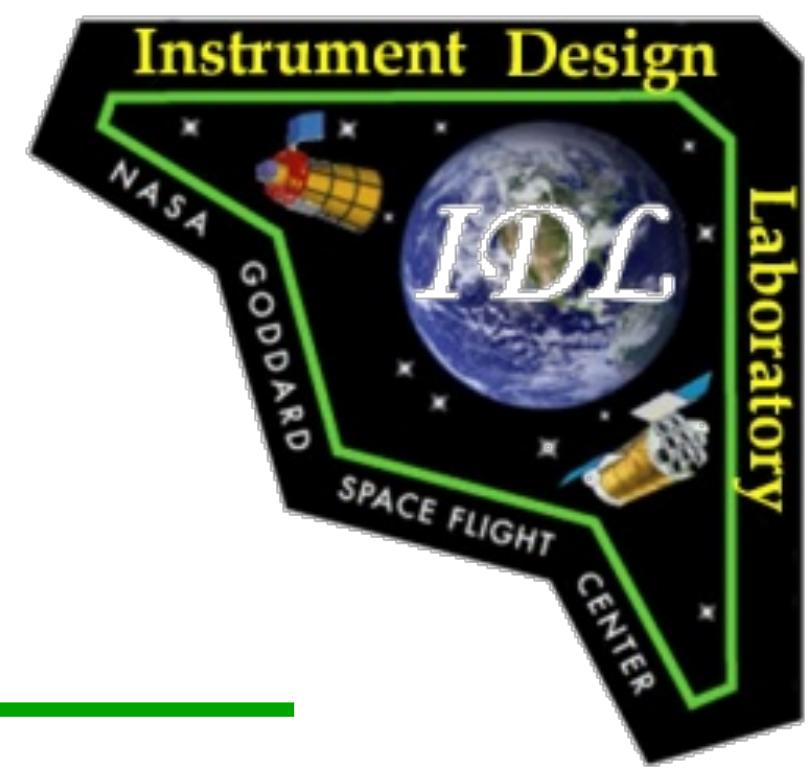
	# of Primary Heater Circuits	# of Redundant Heater Circuits	# of Primary Heater Circuit Thermostats	# of Redundant Heater Circuit Thermostats
MEB	2	2	4	4
MCEB	2	2	4	4
Digitizers	4	4	8	8
Silicon PIN and Preamp	6	6	12	12
InGaAs PIN and Preamp	1	1	2	2
Optics Housing	4	4	8	8
Scan Drum Motor / Encoder	1	1	2	2
Momentum Compensation Motor/Encoder	1	1	2	2
Momentum Compensation Wheel	1	1	2	2
Half Angle Mirror Assembly	1	1	2	2
Half Angle Mirror Motor / Encoder	1	1	2	2
Tilt Mechanism Motor 1/ Resolver	1	1	2	2
Tilt Mechanism Motor 2/Resolver	1	1	2	2
Calibration Target Stepper Motor / Resolver	1	1	2	2
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Thermal. p12

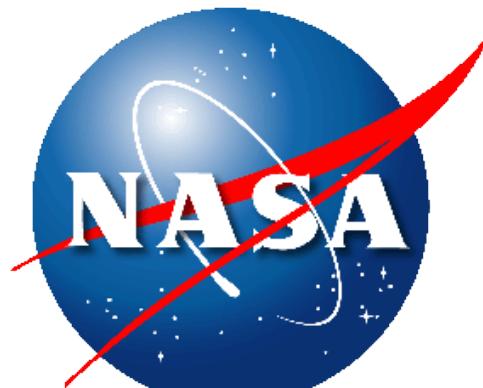
Presentation Version



Radiator and Heater Power Sizing

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- Radiators are sized in worst hot operating case
- Operating mode heater power is sized in worst cold operating case
- GSFC Gold Rules call for a maximum of 70% heater duty cycle for an active heater control thermal design
 - In sizing heater electrical resistance (R), orbital average heater power shall be no more than 70% of peak heater power (V^{**2}/R)
 - Valid for both bang-bang and PID controllers



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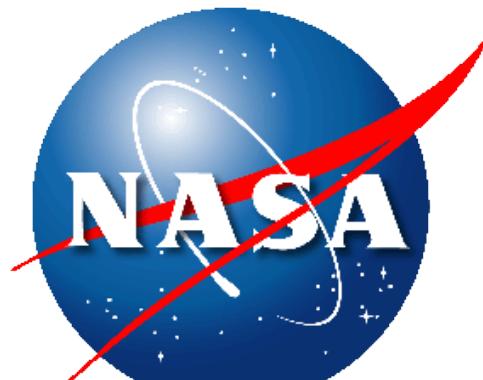
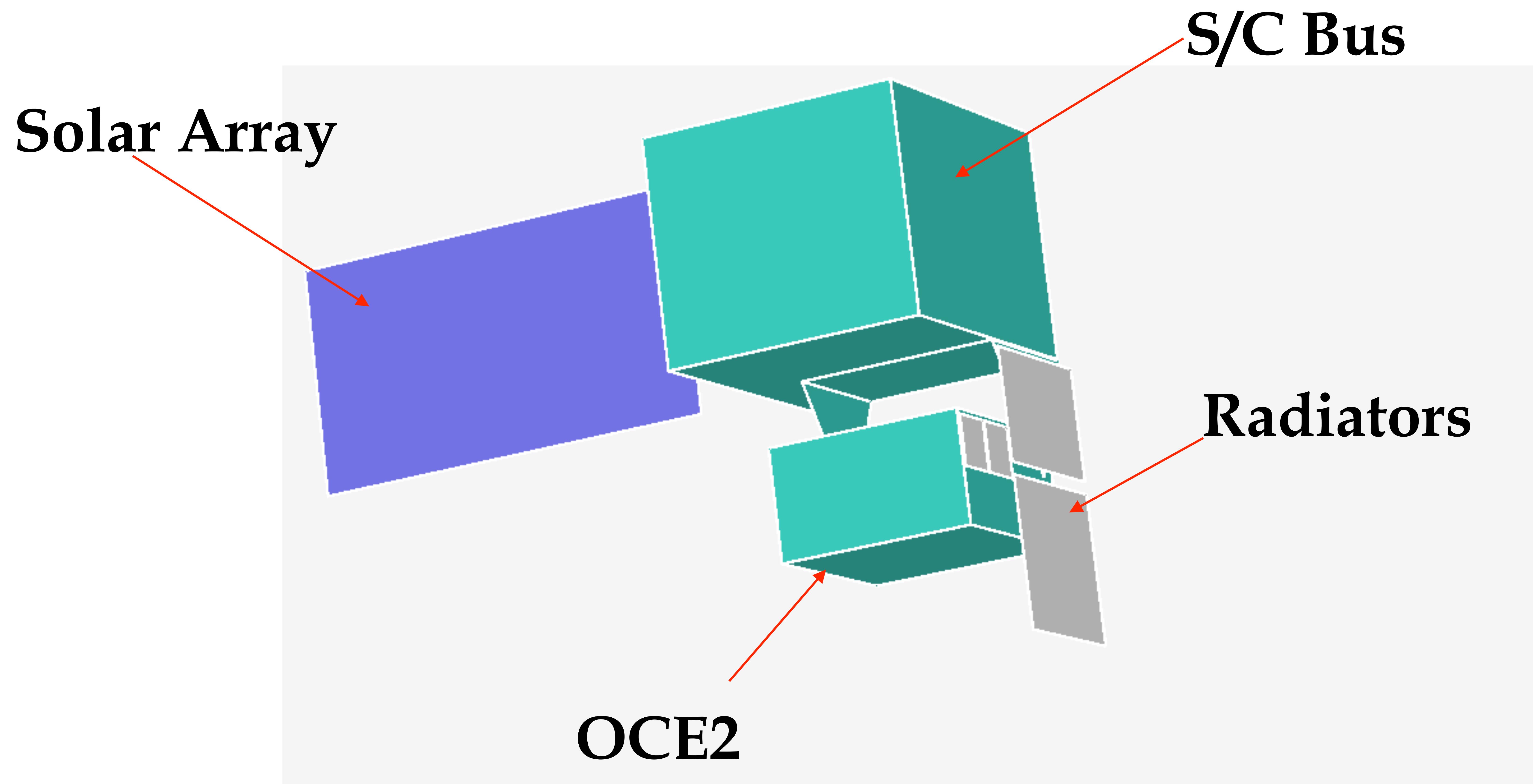
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Thermal, p13
Presentation Version



Thermal Model

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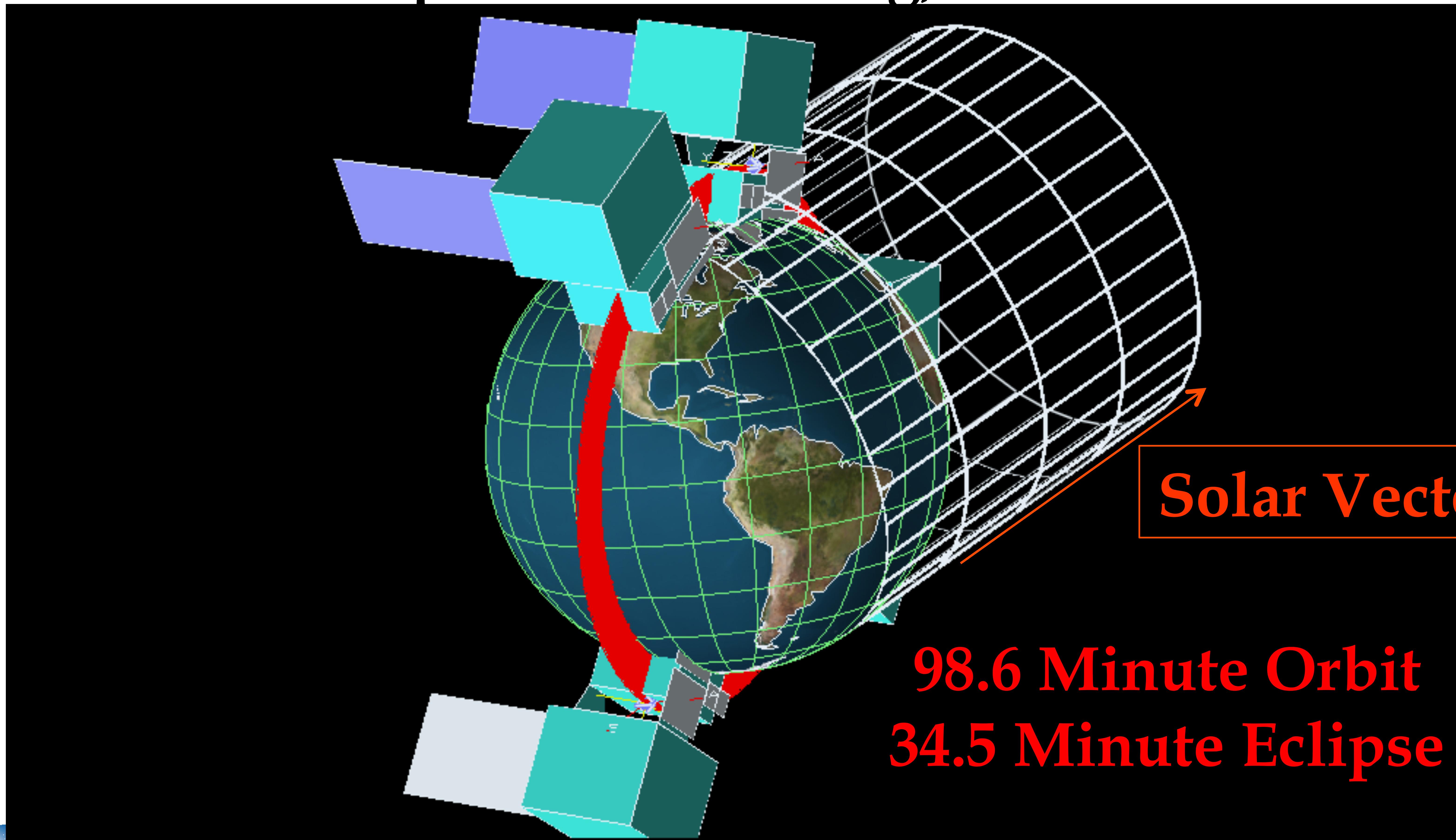
Thermal, p14
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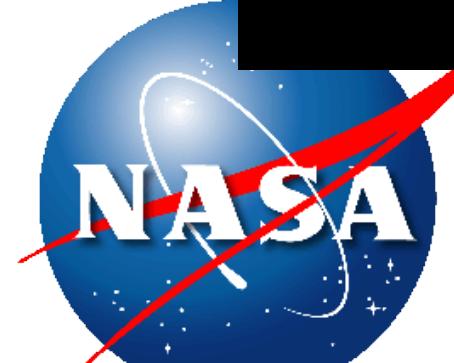
Thermal Model

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1100 Equatorial Crossing, -17° Beta



Spacecraft enlarged to show its orientation



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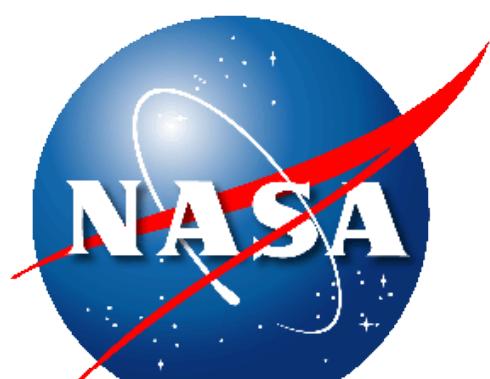
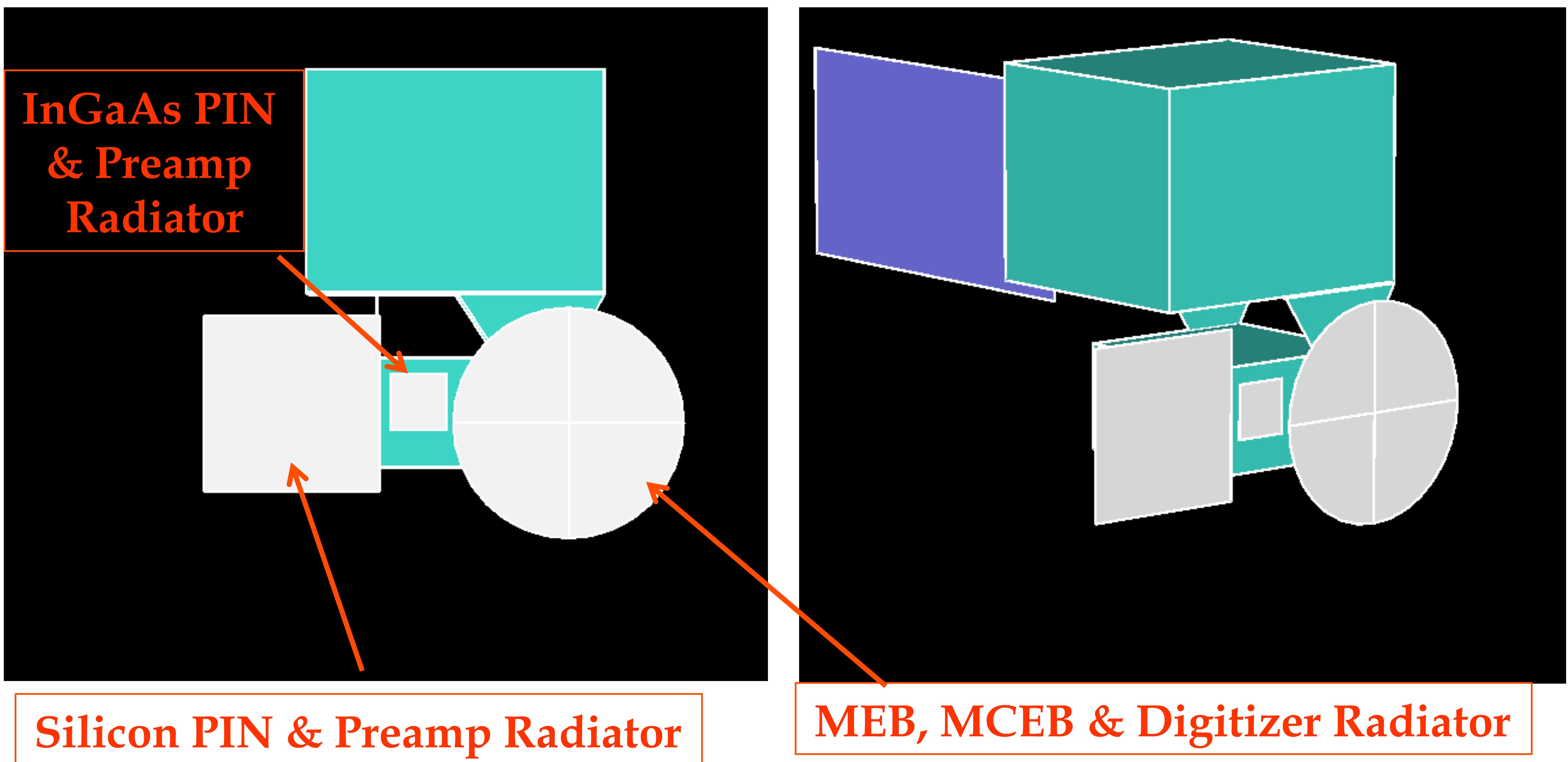
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Thermal, p15
Presentation Version



Radiator Size Predictions

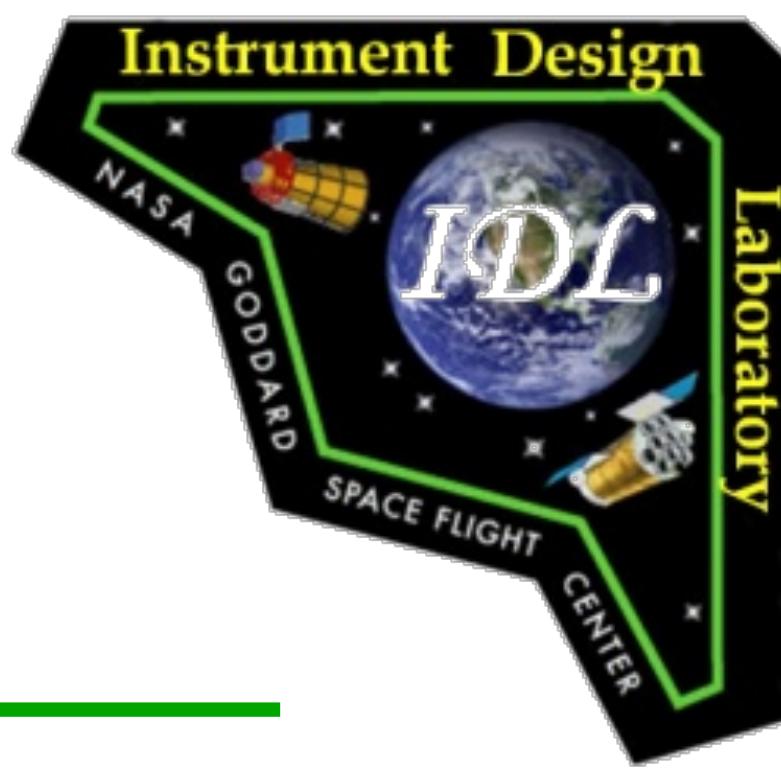
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Thermal, p16
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Radiator Area

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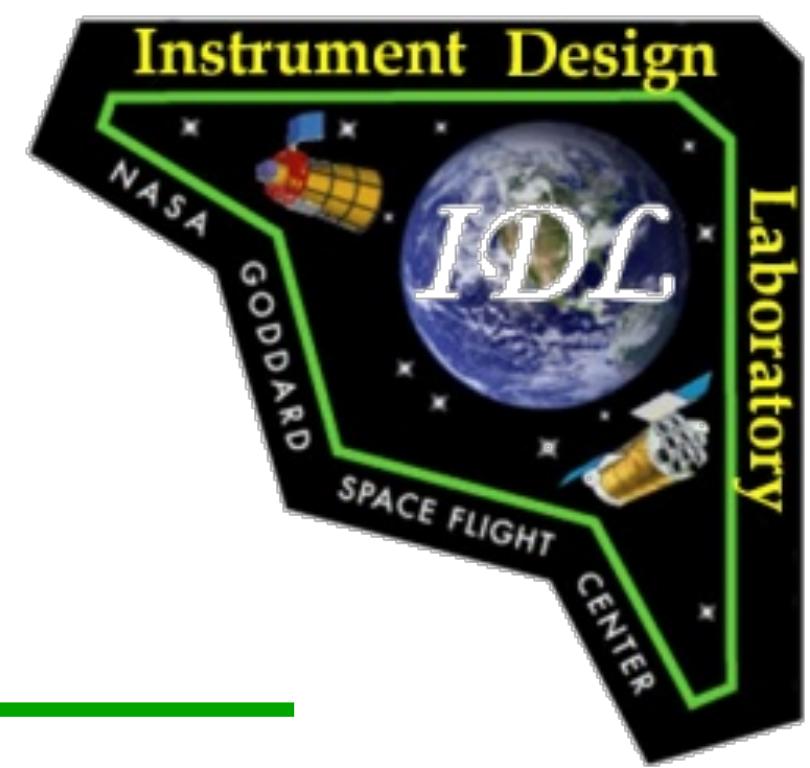
	Coating	Area (m ²)
Silicon PIN and Preamp	AZW-LA-II White Paint	0.511
InGaAs PIN and Preamp	AZW-LA-II White Paint	0.053
MEB, MCEB and Digitizers	AZW-LA-II White Paint	0.696



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Thermal, p17
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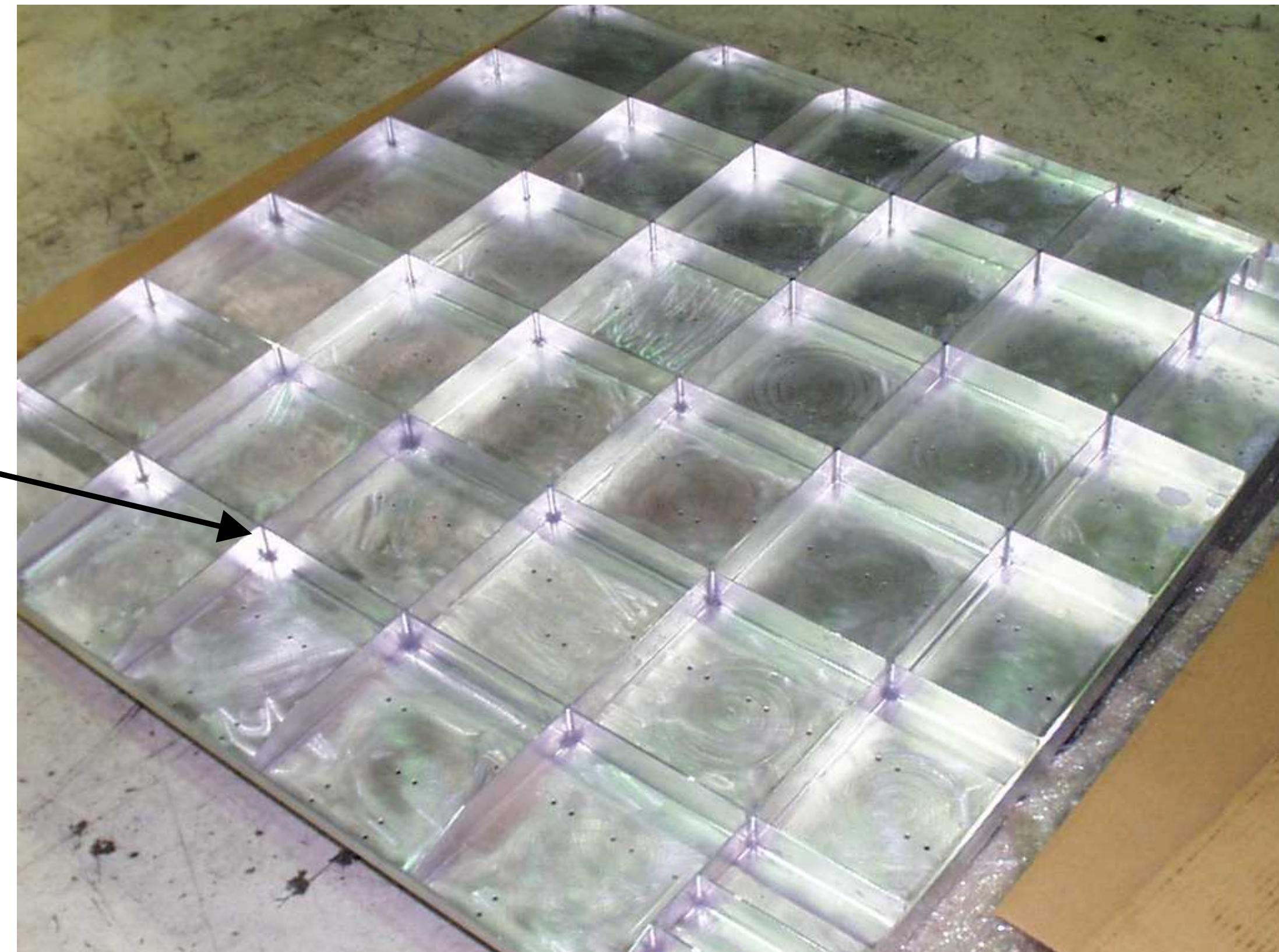


Radiator Area Reduction Option

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- A radiator with grids is an option for reducing radiator footprint
 - Flown on Swift BAT

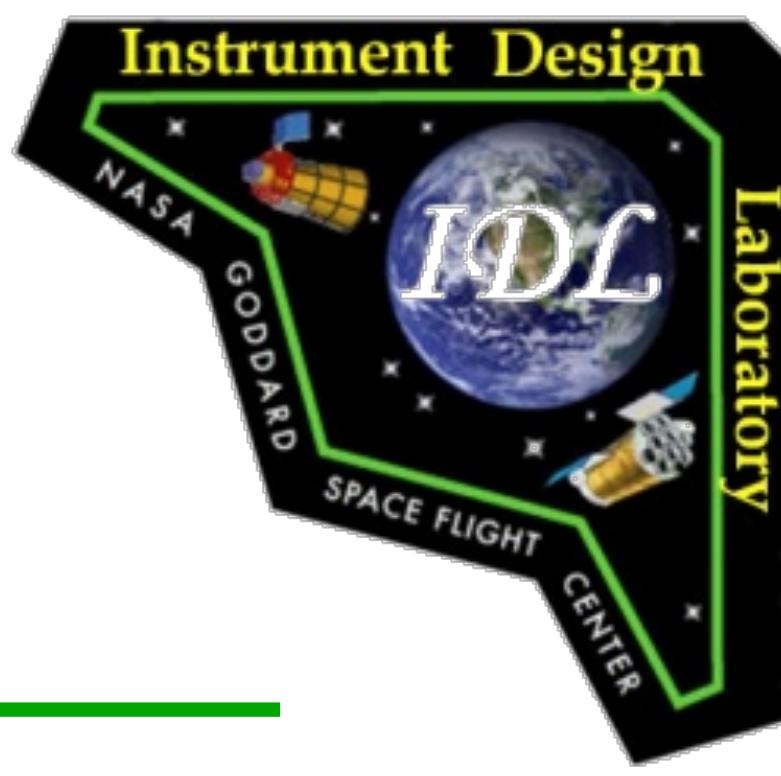
Swift BAT Radiator
(Grids increased
radiator area by 80% but
only increased effective
radiator area by 30%)



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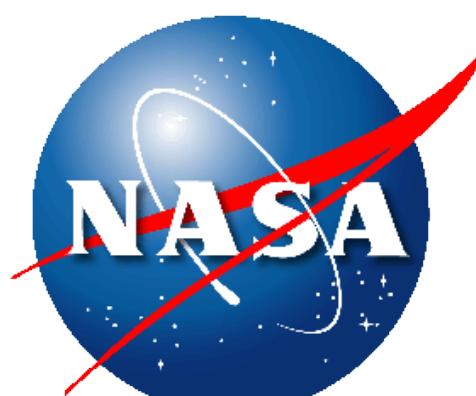
Thermal, p18
Presentation Version



Operating Mode Heater Power

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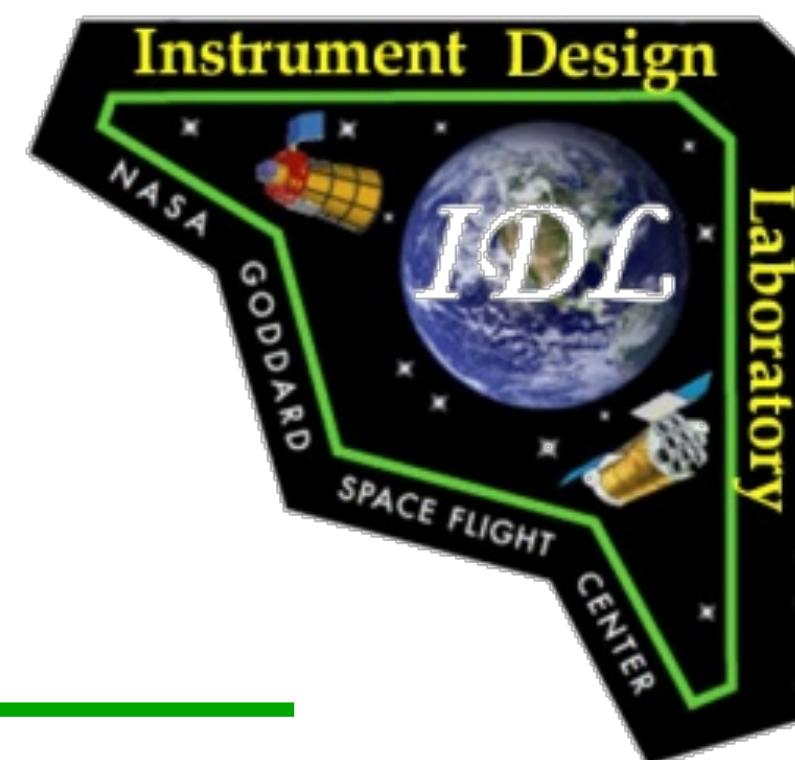
	Average Heater Power (W)	Peak Heater Power (W)
Silicon PIN & Preamp Thermal Box	45	64
InGaAs PIN & Preamp Thermal Box	2	3
Fiber Optics Enclosure	15	21
Optics Housing	10	14
	72	103



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Thermal, p19
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Thermal System Mass Estimate

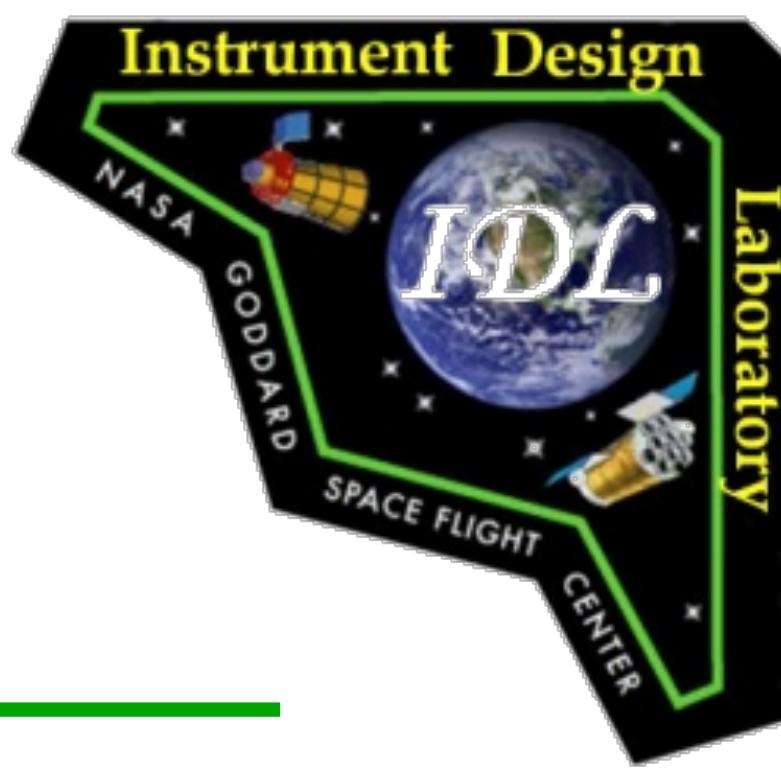
Thermal Subsystem Components	Mass Ea (kg)	Qty	Mass Total (kg)	TRL
Ammonia CCHPs on Silicon PIN/Preamp Thermal Box (0.8 m; 1.27 cm diameter)	0.16	4	0.64	7
Ammonia CCHP Header for Silicon PIN/Preamp Thermal Box (1.5 m; 2.54 cm diameter)	0.6	2	1.2	7
Ammonia CCHPs on InGaAs PIN/Preamp Thermal Box (0.2 m; 1.27 cm diameter)	0.04	2	0.08	7
Ammonia CCHP Header for InGaAs PIN/Preamp Thermal Box (1.5 m; 1.27 cm diameter)	0.3	2	0.6	7
Ammonia CCHPs on MEB, MCEB and Digitizers (3.5 m; 2.54 cm diameter)	1.4	2	2.8	7
Silicon PIN/Preamp Radiator (0.511 m ² ; 2.54 mm thick aluminum)	3.52	1	3.52	7
Silicon PIN/Preamp Radiator AZW-LA-II white paint (0.511 m ²)	0.258	1	0.258	9
InGaAs PIN/Preamp Radiator (0.053 m ² ; 2.54 mm thick aluminum)	0.365	1	0.365	7
InGaAs PIN/Preamp Radiator AZW-LA-II white paint (0.053 m ²)	0.027	1	0.027	9
MEB, MCEB and Digitizer Radiator (0.696 m ² ; 2.54 mm thick aluminum)	4.794	1	4.794	7
MEB, MCEB and Digitizer Radiator AZW-LA-II white paint (0.696 m ²)	0.351	1	0.351	9
Ammonia CCHP Spreaders on Silicon PIN/Preamp Radiator (1 m; 1.27 cm diameter)	0.2	5	1	7
Ammonia CCHP Spreaders on MEB, MCEB and Digitizers Radiator (1 m; 1.27 cm diameter)	0.2	5	1	7
AZ93 white paint on Drum Assembly/Telescope (1 m ²)	0.15	1	0.15	9
Z306 black paint on optics enclosure interior (1.121 m ²)	0.17	1	0.17	9
Z306 black paint on and Drum Assembly/Telescope Interior (1 m ²)	0.15	1	0.15	9
MLI -- Silicon PIN/Preamp Radiator backside (0.511 m ²)	0.307	1	0.307	9
MLI -- InGaAs PIN/Preamp Radiator backside (0.053 m ²)	0.032	1	0.032	9
MLI -- MEB, MCEB and Digitizer Radiator backside (0.696 m ²)	0.418	1	0.418	9
MLI - Fiber Optics Enclosure (2.72 m ²)	1.632	1	1.632	9
MLI - Optics Enclosure (1.121 m ²)	0.673	1	0.673	9
MLI - Detectors internal to Optics Enclosure (0.24 m ²)	0.144	1	0.144	9
MLI - Cradle (1.26 m ²)	0.756	1	0.756	9
MLI - MEB and MCEB (0.726 m ²)	0.436	1	0.436	9
MLI - Digitizers (0.726 m ²)	0.436	1	0.436	9
Velcro, buttons, adhesive, etc. for MLI	0.4	1	0.4	9
Op Heaters -- Kapton Film 5.1 cm x 6.4 cm	0.002	68	0.136	9
Thermostats (Op Heaters) -- Honeywell 3100 Series	0.006	20	0.12	9
Survival Heaters -- Kapton Film 5.1 cm x 6.4 cm	0.002	54	0.108	9
Thermostats (Survival Heaters) -- Honeywell 3100 Series	0.006	108	0.648	9
Thermistors/Platinum RTDs (Op heater control and telemetry)	0.001	60	0.06	9
Adhesive for Heaters, Thermostats and Thermistors and Al Tape for Heaters	0.15	1	0.15	9
Total			23.561	



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Thermal, p20
Presentation Version



Conclusions

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- Radiator area is very large because power dissipation is very high
- Pocketed radiator increases effective area but increases mass significantly
- Could accommodate silicon PIN and preamp radiator as part of a circular disc radiator



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Thermal, p21
Presentation Version